Baculum Size in Pinnipeds

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Baculum size in 20 species of pinnipeds (Order Pinnipedia) is shown in tables 1 and 2. Of the 20 genera of living pinnipeds, all but two *(Otaria* and *Ommatophoca)* are represented here. The tables are designed to show the zoological significance of the ratio: baculum size/body size in certain carnivores which have adopted diverse reproductive habits in the sea. Baculum weight and length are recorded from measurements of the cleaned bone taken, insofar as possible, from full-grown animals. Body weight and length are also recorded, though these are usually estimates based on the known size of other individuals of the same species. An attempt has been made to compare the size of a "typical" full-grown baculum with the size of a "typical" full-grown male body.

We gratefully acknowledge the help of zoologists whose names are given in the sources to table 1; also to Ancel M. Johnson, statistician.

The ratio: baculum weight/body weight varies greatly with the species, in the order of 1 to 183 (table 2). The ratio: baculum length/body length varies in the order of 1 to 3.25. During evolutionary development of the pinnipeds, baculum weight has increased greatly over baculum length. We suppose that increased weight of the baculum, and its corollaries cross-section diameter and strength, have had survival value for certain species.

An important factor operating on baculum size seems to be the environment in which copulation takes place. Insofar as we understand the breeding habits of pinnipeds, the forms listed in table 2 can be arranged in two groups: first, those which copulate in water or on ice, normally with body surface wet; and second, those which copulate on land, normally with body surface dry. Members of the first group have a relatively large baculum; members of the second group a small one. (It would be dangerous to assume, however, that copulation in water has had an exclusive evolutionary influence on development of the baculum, for in cetaceans, the most aquatic of all mammals, a baculum is entirely lacking!)

The elephant seal, heaviest in body, has relatively the lightest baculum (table 2). From this example alone we might be led to suppose that, during the evolution of body size, baculum weight has lagged behind. However, when all of the 17 genera of table 2 are analyzed with respect to the relationship between baculum weight and body weight, the correlation proves to be insignificant ($r = -.218$, when significance at the 95 % level would need to equal $\pm .482$).

An arrangement of species by weight of baculum (table 2) tends to bring phylogenetically related species together. This is another way of saying that baculum size has followed approximately the course of evolution of other body characters, such as skull and dentition, upon which phylogeny of the pinnipeds is based. At the head of table 2 is *Odobenus,* representing the family *Odobenidae;* then 11 genera representing Phocidae; then 5 representing Otariidae; and finally Mirounga which, though classed with the Phocidae, is in some respects a taxonomic riddle.

Table 1

Baculum size in pinnipeds

Species	Baculum specimen number	Age	Baculum length (mm)	Baculum weight (g)	Body length (cm)	Body weight (kg)	Source 1
Otaria byronia (South American sea lion)	—	adult	—	—	246	522	a
Eumetopias jubata (Stellers sea lion)	BDM 300	>10	206	69.4	316	938	b
Zalophus californianus (California sea lion)	—	8—10	121	11.3	177	170	c
Neophoca hookeri (New Zealand sea lion)	MNHN	—	260	—	—	—	d
Arctocephalus pusillus (South African fur seal)	BM (NH) 1953 4. 9. 1	subadult	123	9.9	217	143	e
Arctocephalus tropicalis (Kerguelen fur seal)	—	adult	128	12.5	195	160	f
Callorhinus ursinus (Northern fur seal)	—	>10	142	14.5	193	250	g
Odobenus rosmarus (Walrus)	—	adult	540	980.0	293	1246	h
Odobenus rosmarus (Walrus)	A 114	20	560	1030.0	320	—	i
Phoca vitulina (Harbor seal)	—	adult	137	16.4	156	104	j
Pusa hispida (Ringed seal)	KWK 58—33	adult	118	7.9	114	43	k
Histriophoca fasciata (Ribbon seal)	BDM 543	adult	142	16.4	135	76	l
Pagophilus groenlandicus (Harp seal)	BM (NH) 1951 11.28.2	adult	185+	66.0+	172	140	m
Halichoerus grypus (Gray seal)	B 3	13	163	41.5	236	204	n
Erignathus barbatus (Bearded seal)	KWK 58–23	adult	140	28.8	211	239	o
Monachus schauinslandi (Hawaiian monk seal)	BDM 490	ca. 21	183	41.1	214	172	p
Lobodon carcinophagus (Crabeater seal)	142	adult	220	35.7	225	179	q
Hydrurga leptonyx (Leopard seal)	655, 662	adult	233	60.3	297	220	r
Leptonychotes weddelli (Weddel seal)	37	adult	218	54.3	255	286	s
Cystophora cristata (Hooded seal)	ZMH 3040	ca. 8	210	32.0	280	370	t
Mirounga leonina (Southern elephant seal)	—	6—8	331	109.0	474	2550	u
Mirounga angustirostris (Northern elephant seal)	SDNHM 7296	adult	274	106.0	475	2268	v

Sources of data for table 1

a Length of a Falkland Island specimen measured by Hamilton (1939 b, p. 125); weight of another estimated at "circa 1150 pounds" by Bruce (1915, p. 173); no baculum available.
b Collected on St. Paul Island, Alaska, 6 June 1949, by Kenyon.
c Collected at San Diego, California, 3 January 1951, by Kenyon, who estimated it at 350—400 pounds.
d Baculum of "*Eumetopias hookeri*" in Muséum National d'Historie Naturelle, fide Chaine (1926, p. 151).
e Baculum length and condylobasal length (256 mm) fit well into "Group H" of Rand (1956), upon whose authority body size data are recorded.
f Collected on Bird Island, South Georgia, by W. N. Bonner *(in lit.)*. Maximum data are recorded from the following specimens: body length (FS 60), body weight (FS 23), baculum length and weight (FS 56); all specimens in British Museum.
g Baculum length from specimen BDM 366 collected on St. Paul Island, Alaska, 13 August 1949, by Kenyon; body size estimated at 90 percent of maximum known size of other adults (Scheffer and Wilke, 1953, p. 133, 135). Another baculum of 136 mm and 14.5 g was recorded by Scheffer (1950, p. 391). The weight of this baculum is used in calculating the ratio of baculum length to body weight.
h Baculum only found on beach of St. Paul Island, Alaska, in summer of 1954, by Kenyon; body size estimated at 80 percent of maximum known size of other adults (Buckley, 1958, p. 5).
i Collected by D. E. Sergeant; body size "at least 1200 kg" *(in lit.)*.
j Collected on Amchitka Island, Alaska, 29 September 1955, by Kenyon; body size estimated at 90 percent of maximum known size of other adults (Scheffer, 1958, p. 145).
k Collected on Little Diomede Island, Alaska, 27 May 1958, by Kenyon; body length estimated from known length of another male of similar size taken at the same time; weight estimated at 90—100 pounds.

Table 2

Ratios: baculum weight/body weight and baculum length/body length

Data from table 1 rearranged by decreasing ratio of baculum weight

Species	Percent weight baculum / body	Percent length baculum / body	Copulation in water	Copulation on land
Odobenus rosmarus	0.0787	18.43	—	?
Pagophilus groenlandicus	0.0471	10.76	?	—
Lobodon carcinophagus	0.0357	9.78	×	—
Hydrurga leptonyx	0.0274	7.85	?	—
Monachus schauinslandi	0.0239	8.55	×	—
Histriophoca fasciata	0.0216	10.52	×	—
Halichoerus grypus	0.0203	6.91	×	×
Leptonychotes weddelli	0.0190	8.55	×	—
Pusa hispida	0.0184	10.35	?	—
Phoca vitulina	0.0158	8.78	×	—
Erignathus barbatus	0.0121	6.63	?	—
Cystophora cristata	0.0086	7.50	×	—
Arctocephalus tropicalis	0.0078	6.56	—	×
Eumetopias jubata	0.0074	6.52	—	×
Arctocephalus pusillus	0.0069	5.67	—	×
Zalophus californianus	0.0066	6.84	—	×
Callorhinus ursinus	0.0058	7.36	—	×
Mirounga angustirostris	0.0047	5.77	—	×
Mirounga leonina	0.0043	6.98	—	×

l Collected on Little Diomede Island, Alaska, about 17 June 1958, by KENYON; body size estimated at 80 percent of maximum known size of other adults (SCHEFFER, 1958, p. 146).
m Body size from SIVERTSEN (1941); baculum size from D. E. SERGEANT *(in lit.)*. The British Museum specimen, for which no data are given in the table, is represented by a baculum of 180 mm and 34.3 g.
n Body weight estimated; age assigned from tooth-layer count (H. R. HEWER, *in lit.)*. Grace HICKLING reported *(in lit.)* a baculum of 170 mm (Hancock Museum no. 46).
o Collected on Little Diomede Island, Alaska, 23 May 1958, by KENYON.
p Collected on Midway Atoll, Hawaii, 2 February 1957, by KENYON and D. W. RICE.
q DIDIER (1953, p. 26); the largest af 3 bacula, all adult. Body size estimated at 80 percent of maximum known size of other adults (SCHEFFER, 1958, p. 148).
r HAMILTON (1939a, p. 257, pl. xi); mean of two specimens, each 297 cm in length. Body size estimated at 80 percent of maximum known size of other adults (SCHEFFER, 1958, p. 148). LAWS (1957, p. 50) measured a longer baculum, 300 mm, from a 285 cm seal.
s DIDIER (1953, p. 23); body size estimated at 80 percent of maximum known size of other adults (SCHEFFER, 1958, p. 147).
t Captured in the Faroes in 1954; died Bremerhavener Tiergrotten in 1956; age 14—15 years (ERNA MOHR, in lit.). A Jan Mayen specimen reported by these authors had a baculum of 205 mm and 38 g.
u Mean of four specimens (M 84, M 107, M 111, M 120), from LAWS (1953, p. 39—40) and JUDITH E. KING *(in lit.)*. Largest baculum, 349 mm, 125 g.
v HUEY (1930, p. 229) estimated the weight at "5,000 pounds"; data on the baculum are from HUEY *(in lit.)*.

Summary

In 20 species of pinnipeds the ratio: baculum size/body size is 183 times greater in *Odobenus* than in *Mirounga*. A relatively large baculum is correlated with copulation in water; a small one with copulation on land. The ratio tends to vary with family groupings.

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